Section 1: Background

1.1 Introduction

The University of Florida Unmanned Aircraft Systems Research Program (UF-UASRP) is conducting research on the viability of distributed electric propulsion systems for full scale electric vertical take-off and landing (eVTOL) aircraft control. In order to do this, UF-UASRP is developing a sub-scale unmanned aircraft test aircraft to develop these control schemes that can be used for scaling purposes. The sub-scale unmanned aircraft is the subject of this exemption request.

UF-UASRP currently operates all its systems under 14 C.F.R. Part 107. The test vehicle proposed in this exemption will weigh 195lbs (**N213A**, **UNIV OF FLORIDA UASRP LAB UF16000)**, and will fall outside of the weight range specified for small unmanned air system (sUAS) operations in 14 C.F.R. Part 107.3. Operations outside this weight restriction requires the vehicle to be operated under 14 C.F.R Part 91. However, certain provisions of 14 C.F.R Part 91 and other related regulations in 14 C.F.R. are not applicable to unmanned air systems operations. Thus we are seeking exemption from these provisions in 14 C.F.R Part 91 and related provisions to use the guidelines in 14 C.F.R. Part 107 and Advisory Circular AC 107-2 for UAS operations. We believe that operating under 14 C.F.R. Part 91 while conforming with the regulations in 14 C.F.R. Part 107 and the guidelines in AC 107-2 with the exception of vehicle weight is the best way to achieve safe and efficient operation. The following sections will demonstrate that granting this exemption will ensure high levels of safety.

1.2. Risk Mitigation Overview

Operations will be conducted under 14 C.F.R. Part 91 while adhering to all provisions in 14 C.F.R. Part 107 and the guidelines in AC 107-2 with the exception of vehicle weight. This includes, but is not limited to, environmental limitations (Daytime VMC, under 400 ft AGL, always within Remote Pilot-In-Command (PIC) visual line of sight and never to carry passengers.) It is proposed that all operations will be conducted by fully qualified 14 C.F.R. Part 107 operators.

In order to mitigate the risk posed by operating an aircraft above the weight restriction in 14 C.F.R. Part 107.3, UF-UASRP intends to operate the unmanned aircraft system (UAS) solely at a remote designated Flight Test Area on UF property (University of Florida Plant Science Research and Education Unit in Citra, FL; Area detailed in *Appendix C - Flight Test Area.*) This facility is currently being used for plant science research and is away from populated areas and controlled airspace.

1.3 Funding Source

The funding source for this research is Archer Aviation, which is a private company. The nature of the research funding source does not allow for this specific project to operate as a self-regulated public entity.

Section 2: Regulatory Basis for Exemption Request

The FAA may grant an exemption under *49 U.S.C. §44807 Special Authority For Certain Unmanned Aircraft Systems* if it has determined that such an operation does not create a hazard to users of the national airspace system or the public. As described more fully in Section 3, the requested exemption would ensure that this standard is met through operations under tightly controlled conditions.

In addition to minimizing hazards, this research will also advance the public interest. This effort will contribute to the emerging field of electric vertical take-off and landing (eVTOL) aircraft. The vehicle in this proposed exemption will be used to develop new types of flight control laws, that could greatly enhance safety and simplify operations for this new class of vehicles. This platform is part of several current PhD students' work and it is intended to disseminate the findings of this work through publications to the scientific community once research restrictions are expired.

Research up to this point has been constrained to lab testing and 14 C.F.R. §107.3 compliant models about 20 lbs with a 48" wingspan. The team has made significant strides in understanding this configuration and have implemented these findings into predictive models for a larger aircraft. The team is building the larger 10' wingspan vehicle that will weigh at 195lbs. This 10'/195 lb vehicle is the subject of this petition request. More information about this aircraft can be found in *Appendix E - Aircraft Information.*

Section 3: Granting an Exemption will not Adversely Affect Safety

The University of Florida believes the most applicable standard to its operations are contained within 14 C.F.R. Part 107 and AC 107-2 with the exception of vehicle weight. The team has a long, strong reputation of UAS operation both under 14 C.F.R. Part 107 and the now replaced Section 333 exemption. Operations of this UAS would follow all standards set forth in 14 C.F.R. Part 107 as well as specific internal operational standards established increase personnel safety around this larger aircraft. Due to this vehicle's weight surpassing the limitations of 14 C.F.R. Part 107.3, the University of Florida believes it makes the most sense to describe in this section why the intended operations would not adversely affect safety per 14 C.F.R. §11.81(e) requirements.

3.1 Remote Testing Site

The aircraft would only be operated at a remote test flight area on University of Florida property in Citra, FL (Plant Science Research Center.) This land is entirely fenced in and solely operated by UF personnel. This area is level ground (a plant research field) with no tall structures or obstacles in the path. The testing site is located away from any Class B, C, or D airspace and Restricted Airspaces. This minimizes the impact of the operations on the National Airspace System. It is also located away from population centers (Gainesville, FL & Ocala, FL) which minimizes risk to the greater public. This area is visually depicted in *Appendix C - Flight Test Area.*

Written and/or oral permission from the relevant property holders will be obtained before flight and operational permits obtained through University of Florida EH&S (See *Appendix A - Memorandum of Agreement*)

3.2 Testing Site Buffer Zone

The property extends past the designated flight test area giving a minimum buffer of ¼ mile between the test area and any land owned by entities other than the university. This is specifically established to provide land area buffer that is greater than the range of the vehicle so that even in the worst of failure scenarios, any emergency is constrained to university property where trained personnel are on hand to properly handle the situation.

3.3 Vehicle Redundancies & Failsafes

The vehicle that is being built contains common equipment and flight control software found in its smaller counterparts, but with added redundancies and enhanced safety features. This was done intentionally to allow for operators familiar with smaller vehicles to easily transition to the larger vehicle, all while increasing the level of safety. The following is a list of specific redundancies and safety features incorporated by the aircraft:

1. Auto descent (landing) if communication signal were to be severed. If the UAS loses communications, the UAS has the capability to return to a predetermined location within the Flight Test Area and land.
2. Alert Flight Test Crew and advise descent (landing) if battery were to drop below nominal levels.
3. Flights will automatically return-to-home at 25% battery energy reserve.
4. Live telemetry link for operator gives real-time positioning and vehicle health feedback.
5. The UAS will have the capability to abort a flight in case of unpredicted obstacles or emergencies.
6. On-Screen-Display (OSD) contains operating information to ascertain vehicle health at all times: speed, altitude, number of GPS satellites (when available), heading and voltage.

7. GPS lock supplies for return-to-home (RTH). Should Command and Control (C2) link failures occur, vehicle returns automatically to the point of launch.
8. Altitude information will be provided to the UAS pilot via a digitally encoded telemetric data feed, which downlinks from the aircraft to a ground-based on-screen display. This altitude information will be generated by equipment installed on board the aircraft, using GPS triangulation, or digitally encoded barometric altimeter, or radio altimeter, or any combination thereof. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by the pilot.
9. Flight Computer utilizes redundant Inertial Measurement Units (IMUs) for error correction and to maintain flight control should a single system fail.
10. Vehicle utilizes redundant primary communication radios for error correction and to maintain control link with pilot should a single radio fail. If both radios fail, may attempt backup pilot control available through the telemetry link or allow the vehicle to execute lost-link procedures as described above.
11. All aircraft operated in accordance with this exemption will be identified by serial number, registered in accordance with 14 C.F.R. Part 47, and have identification (N-Number) markings in accordance with 14 C.F.R. Part 45, Subpart C. Markings must be as large as practicable.
12. Total on-board battery energy will be below the capacity required to fly outside the test site. This means that in the unlikely failure of all failsafes, the vehicle will terminate within the boundary of the test site, minimizing risk to the public. This feature is essentially a “dead man's switch.”

3.4 Flight Operation Restrictions

The operation of vehicle, will be conducted in the strict conditions outlined in 14 C.F.R. Part 107, and will provide an equivalent level of safety supporting the grant of the exemption from certain 14 C.F.R. Part 91 and related 14 C.F.R requirements. The following sections describe the operational restrictions that will complied with to ensure the applicable safety standards are met according to 14 C.F.R. Part 107.

3.4.1 Flight Crew

1. The Pilot-In-Command (PIC) will possess a 14 C.F.R. Part 107 Certificate to display UAS specific knowledge and operational competence.
2. Pilot and observer will have been trained in operation of UAS (through 14 C.F.R. Part 107 certification) and received up-to-date information on the particular UAS to be operated.
3. The PIC will obtain the consent of all persons involved in the UAS operations and ensure that only consenting persons will be allowed within 100 feet of the flight operations.

4. Observer and PIC will at all times be able to communicate by voice. Should there be any lapse in communication or confusion for the PIC, flight will be terminated and vehicle safely landed in the predetermined area.
5. The UAS will not be operated directly over any persons.
6. Security will be established for the flight area as part of the pre-flight control. No one will be allowed into the area without the permission of the remote pilot-in-command. Each individual within the secure area will be briefed prior to flight and will consent to being in the area. All others will be excluded from the area.
7. The PIC (or a person with delegated authority by the PIC) must ensure that no persons are allowed within 500 feet of the area except those consenting to be involved and necessary for the flight test operations.

For full roles and responsibilities of the flight crew, please see *Appendix H - Flight Test Personnel.*

3.4.2 Pre-Flight Procedures

1. Prior to each flight the PIC must inspect the UAS to ensure it is in a condition for safe flight. The preflight inspection will account for all discrepancies, i.e. inoperable components, items, or equipment, not covered in the relevant preflight inspection sections of the operator's manual. Advisory Circular AC 107-2 will be used as a guideline for these preflight procedures.
2. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight. The Ground Control Station will be included in the preflight inspection. All maintenance and alterations will be properly documented in the aircraft records.
3. Before conducting operations, radio spectrum analysis will be used to check for interference on the frequencies utilized for vehicle control/communication and distance check to verify strong reception across Flight Test Area.
4. Briefings will be conducted in regard to the planned UAS operations prior to each day's activities. It will be mandatory that all personnel who will be performing duties within the boundaries of the safety perimeter be present for this briefing. Briefings are provided in *Appendix F - Briefings.*
5. As part of the pre-mission briefing and flight card generation for each flight, a mission risk assessment must be performed and verified by the PIC per the FAA's Risk Management Handbook (FAA-H-8083-2) and Advisory Circular AC 107-2 resources.
6. Flight test cards are generated for all flights which are a detailed description of all maneuvers to be completed during the flight. No deviation of the flight card will be allowed for flight operations. All personnel will be familiarized with information on the

flight card based the flight test engineer briefing (*Appendix F - Briefings*) A sample flight card is provided in *Appendix G - Sample Flight Test Card.*

7. All charging and storage of lithium polymer batteries will be shielded in fireproof bags since batteries are required to be charged before flight. Class ABC fire extinguishers will always be at-hand on-site and flight test crew trained in basic fire safety (operation of extinguishers and characteristics of battery fires.)

3.4.3 Performance Restrictions

1. Flights will be operated at an altitude of no more than 400 feet above ground level (AGL), as indicated by the procedures specified in the flight test card and/or operators manual. This is done to minimize the risk of interference with another aircraft since it is below Class E airspace and falls within the rules set forth in 14 C.F.R. Part 107.
2. The UAS will not be flown at a ground speed exceeding 50 knots.
3. The UAS will not be operated by the PIC from any moving device or vehicle.

3.4.4 Line-of-Sight Requirements

1. The UAS will be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses. The vehicle distance will never exceed 1000ft from the pilot and flight test crew, thus eliminating the concern of signal severance (flying behind objects/walls).
2. Spotters will be utilized to ensure safe operation and act as a redundant set of eyes for the Pilot-In-Command (PIC.)

3.4.5 Environmental Restrictions

1. UAS operations will not be conducted during the night, as defined in 14 C.F.R. § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.
2. The UAS will not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

3.4.6 Airspace and Air Traffic Restrictions

1. The UAS will not operate in Class B, C, D or E airspace.
2. The UA will remain clear and yield the right of way to all other manned operations and activities at all times (including, but not limited to, ultralight vehicles, parachute activities, parasailing activities, hang gliders, etc.).
3. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable exemption will be reported to the FAA's UAS Integration Office (AFS-80) within 24 hours. Accidents will be reported to the National Transportation Safety Board (NTSB) per instructions

contained on the NTSB Web site: www.ntsb.gov. Further flight operations may not be conducted until the incident, accident, or transgression is reviewed by AFS-80 and authorization to resume operations is provided.

For more on proposed flight operations, please see *Appendix D - Proposed Flight Test Operations.*

3.5 Operators Manual

The template for operator's manual is provided as *Appendix B - Operators Manual Template*, however the final and comprehensive vehicle manual will be developed alongside the vehicle. This vehicle will utilize several independent component systems from trusted manufacturers and, where applicable, the component manual will be included with the vehicle manual.

The operators manual is a living document and a critical component to the safe development of the vehicle prototype. The most recent update of the operator's manual and this petition for exemption will be maintained and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operator's manual, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator will follow the procedures as outlined in its operator's manual.

The operator may update or revise its operator's manual. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator upon request.

If the operator determines that any update or revision would affect the basis for which the FAA grants this petition for exemption, then the operator must petition for amendment to their exemption. The FAA's UAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operator's manual.

3.5 Maintenance Record & Procedures

In addition to the operator's manual, a maintenance record will also be kept. The maintenance record will contain all relevant changes to the aircraft after the organizational internal flight readiness review (which occurs at the end of the aircraft build.) This record will contain preventative maintenance, alterations, status of replacement/overhaul component parts, and the total time in service of the UAS.

In addition, if there are any changes that occur during maintenance that affect the UAS operation or flight characteristics, e.g. replacement of a flight critical component, the UAS will undergo a functional test flight in accordance with internally established procedures. The PIC who conducts the functional test flight will make an entry in the maintenance records of the flight.

Where applicable, UF-UASRP will follow the component manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements. When unavailable, aircraft maintenance/component/overhaul, replacement, and inspection/maintenance requirements will be established and identified in the operator's manual. At a minimum, maintenance requirements for the following will be included in the operator's manual:

a. Powerplant (motors);
b. Propellers;
c. Electronic speed controller;
d. Batteries;
e. Remote command and control;
f. Ground control station (if used); and
g. Any other components as determined by the operator;

The UAS operated under this exemption will comply with all component manufacturer Safety Bulletins.

Section 4: Regulatory Provisions from which the UF-UASRP seeks an Exemption

The University of Florida Unmanned Aircraft Systems Research Program (UF-UASRP) believes it will require exemptions from the following provisions in 14 C.F.R. to conduct research critical to the development of a 195lb unmanned aircraft prototype. In-lieu of these specified exemptions, 14 C.F.R. Part 107 provisions will be used. The following provisions that are requested for exemption are as follows:

- 14 C.F.R. Part 21, Subpart H, Certification procedures for products and parts, Airworthiness Certificates
- 14 C.F.R. Part 61, Certification: Pilots, Light Instructors, and Ground Instructors
- 14 C.F.R. Part 91.103 Preflight action
- 14 C.F.R. Part 91.105, Flight crewmembers at stations
- 14 C.F.R. Part 91.119, Minimum safe altitudes
- 14 C.F.R. Part 91.121, Altimeter settings
- 14 C.F.R. Part 91.151, Fuel requirements for flights in VFR conditions
- 14 C.F.R. Part 91.405, Maintenance required
- 14 C.F.R. Part 91.407, Operation after maintenance
- 14 C.F.R. Part 91.409, Inspections
- 14 C.F.R. Part 91.417, Maintenance records

The following sections will describe how granting these exemptions will not adversely affect safety:

Notes Regarding: 14 C.F.R. Part 21, Subpart H, Certification procedures for products and parts, Airworthiness Certificates

UF-UASRP requests that no airworthiness certificate will be issued for the UAS. The original intent of aircraft certificates was to display an aircraft's airworthiness, certification, and registration documents so they would be easily available to inspectors and passengers. Based on the FAA Memorandum subject "Interpretation regarding whether certain required documents may be kept at an unmanned aircraft's control station," dated August 8, 2014, the requested relief from 14 C.F.R. Part 91.9(b)(2) and 91.203(a) and (b) is not necessary.

In-Lieu of exemption of airworthiness certificates, UF-UASRP proposes to follow the guidelines in 14 C.F.R. Part 107.15, AC 107-2 5.5 and AC 107-2 Chapter 7. These regulations and guidelines from AC 107-2 have proven to be sufficient for safe operation of sUAS in the National Airspace System. UF-UASRP proposes to use this same guidance for our aircraft and operations. In addition to following these guidelines, risk to persons or objects will be minimized. since our aircraft will not be operating in a remote environment.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 21, Subpart H

- 14 C.F.R. Part 107.15 Condition for safe operation
- AC 107-2 5.5 sUAS Maintenance, Inspections, and Condition for Safe Operation
- AC 107-2 Chapter 7. sUAS Maintenance and Inspection

Notes Regarding: 14 C.F.R. Part 61, Certification: Pilots, Light Instructors, and Ground Instructors

UF-UASRP seeks an exemption to allow UAS operators to be certified under 14 C.F.R. Part 107 instead holding a 14 C.F.R. Part 61 certificate for the proposed operations. Since the proposed operations will be conducted in a remote environment and under the same operational limitations (with the exception of aircraft weight) as 14 C.F.R. Part 107, we anticipate that this risk will be minimal. In addition, operator certificates under 14 C.F.R. Part 107 are more closely aligned with our actual UAS operations than certificates under 14 C.F.R. Part 61. This is due to extra training required specific to UAS, as outlined in Advisory Circular AC 107-2. As such, UF-UASRP believes that certificates under 14 C.F.R. Part 107 represents a higher level of safety than 14 C.F.R. Part 61 operator certificates.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 61

- 14 C.F.R. Part 107.61 Eligibility
- Advisory Circular AC 107-2 Chapter 6 Part 107 Subpart C, Remote Pilot Certification

Notes Regarding: 14 C.F.R. Part 91.103, Preflight action

UF-UASRP seeks to use the guidance from 14 C.F.R. Part 107.49 in-lieu of guidance from 14 C.F.R. Part 91.103 for preflight action. Guidance that is specified in 14 C.F.R. Part 107.49 is more specific to the operations of UAS systems. As such, UF-UASRP believes that this represents a higher level of safety than operations under 14 C.F.R. Part 91.103 for preflight action.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 91.103

- 14 C.F.R. Part 107.49 Preflight familiarization, inspection, and actions for aircraft operation.
- AC 107-2 5.9 Preflight Familiarization, Inspection, and Actions for Aircraft Operation

Notes Regarding: 14 C.F.R. Part 91.105, Flight crewmembers at stations

UF-UASRP proposes to use the flight crewmembers as specified in 14 C.F.R. Part 107.19, Part 107.31 and 107.33 in-lieu of flight crewmember stations specified in 14 C.F.R. Part 91.105. 14 C.F.R Part 91.105 is specified for manned aircraft, and as such, these guidelines do not apply to the operations of UAS. For example, the role of visual observer is not a traditional flight crewmember station. However, this becomes important for visual line-of-sight (VLOS) operations for UAS aircraft.

The guidelines specified under 14 C.F.R. Part 107 are more applicable to UAS operations, and as such, UF-UASRP believes that this represents a higher level of safety than 14 C.F.R. Part 91.105 guidance.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 91.105

- 14 C.F.R. Part 107.19 Remote pilot in command,
- 14 C.F.R. Part 107.31 Visual line of sight aircraft operation and
- 14 C.F.R. Part 107.33 Visual observer.

Notes Regarding: 14 C.F.R. Part 91.119, Minimum safe altitudes

UF-UASRP submits that the only relief it requires from 14 C.F.R. Part 91.119 is from the minimum altitudes listed in paragraph (c). Relief is required from paragraph (c) for fixed wing operations because asset evaluation conducted at 500 feet or higher is insufficiently distinct to be meaningful. Since operations at this altitude also pose a heightened risk of collision with another aircraft, safety can only be assured through the grant of an exemption. The anticipated rotorcraft operations should be adequately addressed by paragraph (d) (1). Additionally, relief should not be needed from paragraph (a) because an emergency landing of the aircraft due to a power failure will not create an undue hazard to persons or property on the surface.

As noted in the explanation of why an exemption will not adversely affect safety, UF-UASRP has exclusive use of the land over which the UAS will be operated (since we are operating at a University of Florida owned remote facility), and public access is restricted.

Lastly, UF-UASRP proposes to use the guidelines in 14 C.F.R. Part 107.51 and AC 107-2 5.10 in-lieu of 14 C.F.R. 91.119 for operating limitations. Due to the factors that this aircraft will be operating low, slow and in a remote facility, we do not anticipate any significant risk posed by an exemption to 14 C.F.R. Part 91.119.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 91.119

- 14 C.F.R. Part 107.51 Operating limitations for small unmanned aircraft.
- AC 107-2 5.10 Operating Limitations for Small UA.

Notes Regarding: 14 C.F.R. Part 91.121, Altimeter settings

As the UAS may not have a barometric altimeter, but instead a GPS altitude readout, an exemption is needed. An equivalent level of safety will be achieved by the operator, pursuant to the Manual and Safety Checklist, confirming the altitude of the launch site shown on the GPS altitude indicator before flight. Altitude information will be provided to the UAS operator via a digitally encoded telemetric data feed, which downlinks from the aircraft to a ground-based on-screen display. This altitude information will be generated by equipment installed on board the aircraft, using GPS triangulation, or digitally encoded barometric altimeter, or radio altimeter, or any combination thereof. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by the pilot.

The use of GPS aided altitude (and other alternative measures) are outlined in Advisory Circular AC 107-2 5.10.2. UF-UASRP proposes to use these measures for accurate altitude information.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 91.121

- Advisory Circular AC 107-2 5.10.2 Determining Altitude

Notes Regarding: 14 C.F.R. Part 91.151, Fuel requirements for flights in VFR conditions

Operating the UAS in a pre-defined area with less than 30 minutes of reserve fuel does not raise the type of risk contemplated by §91.151, i.e., that an aircraft could run out of fuel in the event it has to be flown to an alternate airport or circle the planned airport in the event of unanticipated conditions. UF-UASRP does not intend to use the UAS for point-to-point flights and will not operate the UAS beyond visual line of sight. Nor will the UAS require an airport in order to land. Rather, UF-UASRP will operate the sUAS using pre-planned flight paths (taking into account weather conditions) designed to allow the UAS to fly to the point of intended landing. As such, there is no need for a time based excess fuel requirement. Rather it should be sufficient to require only as much additional excess flight capacity as necessary to safely land the UAS. We believe that a 25% battery reserve is more than sufficient to meet this objective. In short, UF-UASRP proposes to use the guidelines specified in 14 C.F.R Part 107.49(d) and AC-107-2 5.9.1 Paragraph 4 for energy reserve requirements.

Proposed Guidelines used in-lieu of 14 C.F.R. Part 91.151

- 14 C.F.R. Part 107.49(d) Preflight familiarization, inspection, and actions for aircraft operation.
- AC 107-2 5.9.1 Paragraph 4

Notes Regarding: 14 C.F.R. 91.405, Maintenance required; 14 C.F.R. 91.407, Operation after maintenance; 14 C.F.R. 91.409, Inspections and 14 C.F.R. 91.417, Maintenance records

UF-UASRP believes that an exemption from these maintenance requirements is appropriate because the FAA has not developed maintenance standards that would allow an operator to meet the Part 91 maintenance requirements. In particular, there are no individuals authorized by the FAA to approve a UAS for return to service under §91.407(a) or to conduct the initial airworthiness and annual return to service inspections required by §91.409(a).

UF-UASRP will maintain the aircraft as instructed in the guidelines of 14 C.F.R. Part 107.15, 14 C.F.R. Part 107.49 and Advisory Circular AC 107-2 Chapter 7. Since UF-UASRP is the manufacturer of the UAS, all maintenance will be performed according to exact engineering guidelines.

Proposed Guidelines used in-lieu of 14 C.F.R. 91.405, 91.407, 14 C.F.R. 91.409 and 14 C.F.R. 91.417

- 14 C.F.R. Part 107.15 Condition for safe operation
- 14 C.F.R. Part 107.49 Preflight familiarization, inspection, and actions for aircraft operation.
- Advisory Circular AC 107-2 Chapter 7. sUAS Maintenance and Inspection

The UF-UASRP believes relief in the form of an exemption are only required for the above listed regulations. Should the FAA believe additional relief is required for UF-UASRP to operate in the capacity described, we request an exemption from these additional provisions as well.

Dr. Peter Ifju, Principal Investigator
University of Florida Unmanned Aircraft Systems Research Program
Department of Mechanical & Aerospace Engineering
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New Engineering Building Room 131
Gainesville, FL 32611
352-392-6744
ifju@ufl.edu

Appendix A - Memorandum of Agreements

UF | UNIVERSITY of FLORIDA

Institute of Food and Agricultural Sciences
Research Administration
Plant Science Research and Education Unit

2556 W. Highway 318
Citra, FL 32113-2132
(352) 591-2678
Fax (352) 591-1578

June 14, 2019

RE: Support Letter for Use of Plant Science Research and Education Unit for Unmanned Aircraft Research

Dr. Ifju,

This letter is to confirm that we will provide you and your research team support to conduct the study on unmanned electric vertical take-off and landing (eVTOL) aircraft research at the UF IFAS Plant Science Research and Education Unit (PSREU), located in Citra, Florida. PSREU supports the research conducted by the University of Florida - Unmanned Aircraft Systems Research Program (UF-UASRP) for their research on unmanned electric vertical take-off and landing (eVTOL) aircraft research.

We strongly support your research proposal and approve UF-UASRP's use of our 1,086 acre facility. It is a remote, secure location, well suited for their research and flight test operations.

We are looking forward to cooperating on this project. Thank you in advance for your attention to this matter.

Sincerely,

James A. Boyer
Director of Research Administration
Plant Science Research and Education Unit

UF | UNIVERSITY of FLORIDA

Business Affairs
Division of Environmental Health & Safety

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June 10, 2019

Kalem Dinkel
UFUASRP

RE: N213A Testing Site

Please consider this correspondence as an approval from the Office of Unmanned Aircraft Systems regarding your proposed flight testing of N213A.

As you are aware, your blanket permit will be issued for the Citra, FL. test site once your registration in the EH&S website is complete (after obtaining the required FAA registration). Flight logs will be required and must be submitted every two weeks for the duration of the valid permit time.

Should you need any further assistance please don't hesitate to ask.

Sincerely,

John Rouse

sUAS / Drone Program Coordinator
Office of Unmanned Aircraft Systems
Environmental Health & Safety, Risk Management

Appendix B - Operators Manual Template

1. Legal
    a. Registration
    b. COA
2. Maps
    a. GNV/OCF Area Sectional
    b. GNV/OCF Area Block Ceilings
    c. Citra Overview
    d. Citra FTA Detailed
3. Procedures
    a. Normal Operations Checklists
    b. Emergency Operations Checklists
    c. Field Equipment Checklist
    d. Debriefing Checklist
4. Miscellaneous
    a. Pilot Certifications
5. Flight Logs
6. Maintenance Logs
    a. Discrepancy Log
7. Build Log
8. Systems
    a. Airframe Summary
    b. Mission Sizing
    c. Power Architecture
    d. Controller Architecture
    e. Performance Data

EXAMPLE: Chapter 3 - Procedures, Normal Operations Checklists

Preflight Inspections

- Ensure external antennas are secure and free of entanglement.
- Ensure propellers are secure and spin free.
- Verify placements of batteries for correct CG.
- Verify transmitter and ground station telemetry are live with sufficient charge.
- Check vehicle landing gear for cracks or signs of distress.

Power On Checklist

1. Ensure all disconnects are pulled from the aircraft.
2. Ensure precharge relays are not activated and pre-charge switches are in the off position.

3. Ensure transmitter killswitch is in the ENGAGED position.
4. Verify flight mode switch is set to Stabilize.
5. Clear aircraft of non-critical personnel.
6. Connect hover and cruise batteries to disconnects.
7. Connect avionics battery.
8. Verify primary and backup telemetry connections.
9. Verify vehicle avionics have booted.
10. Verify GPS fix.
11. Verify flight mode is set to Stabilize.
12. Activate flight controller safety switch.
13. Clear aircraft 50 meters.
14. Remotely activate precharge circuitry.
15. After 10 seconds, verify precharge.
16. Remotely activate vehicle disconnects, announce "Aircraft live."
17. Check battery levels reported.

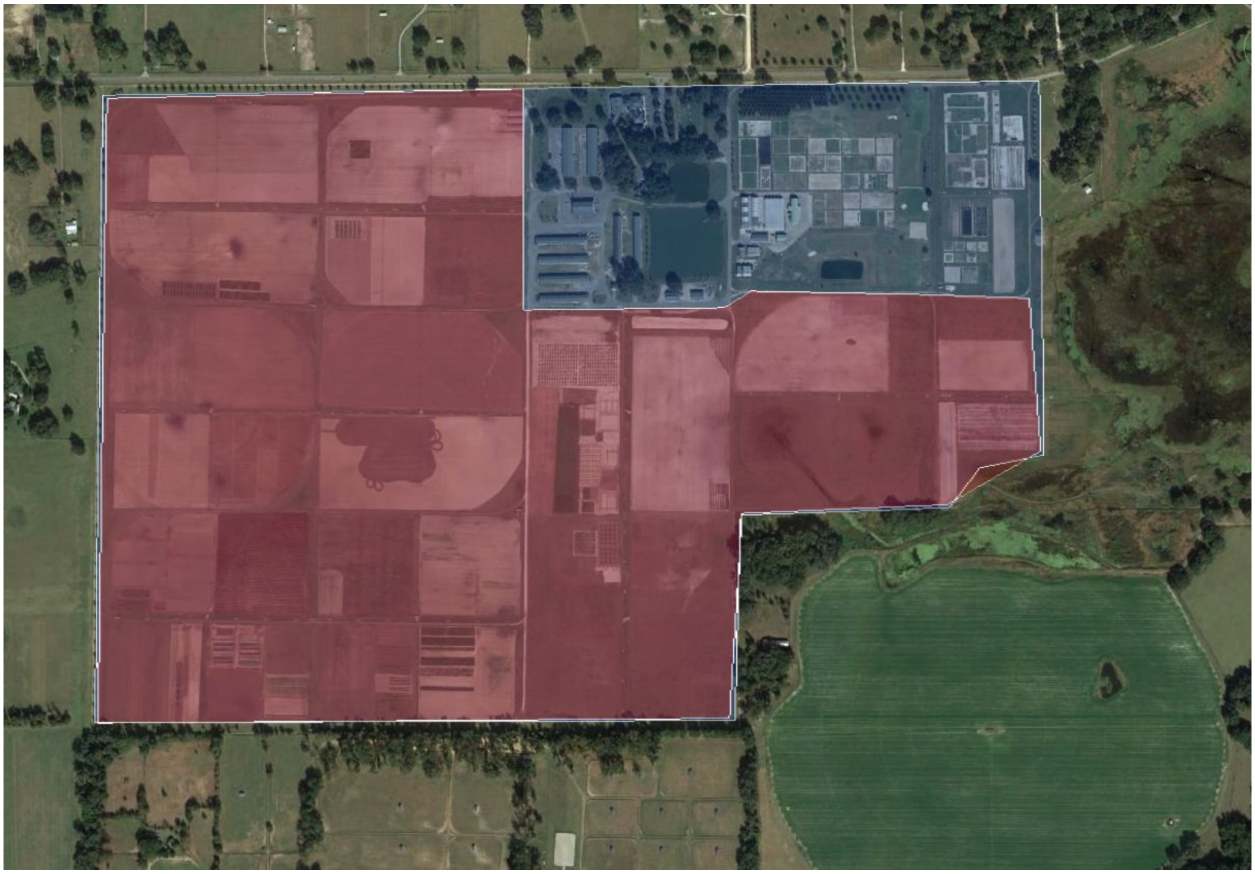
Post-landing Checklist

1. Disarm aircraft.
2. Activate remote disconnects.
3. Activate controller discharge circuit.
4. Ensure controller voltage levels are <1V.
5. Remove fuselage hatch and disconnect batteries.
6. Check battery temperatures.
7. Safe batteries on battery cart.

Aircraft Maintenance

1. Check that propellers are secure and spin freely.
2. Check that inducted fans are secure and spin freely.
3. Check aircraft landing gear for any cracks, markings, or signs of distress.
4. Check fuselage hatch is secure when fastened.
5. Verify accuracy of vehicle battery monitors.
6. Check avionics antennas are clear and have no signs of distress.
7. Verify functioning of vehicle precharge and disconnect circuitry.

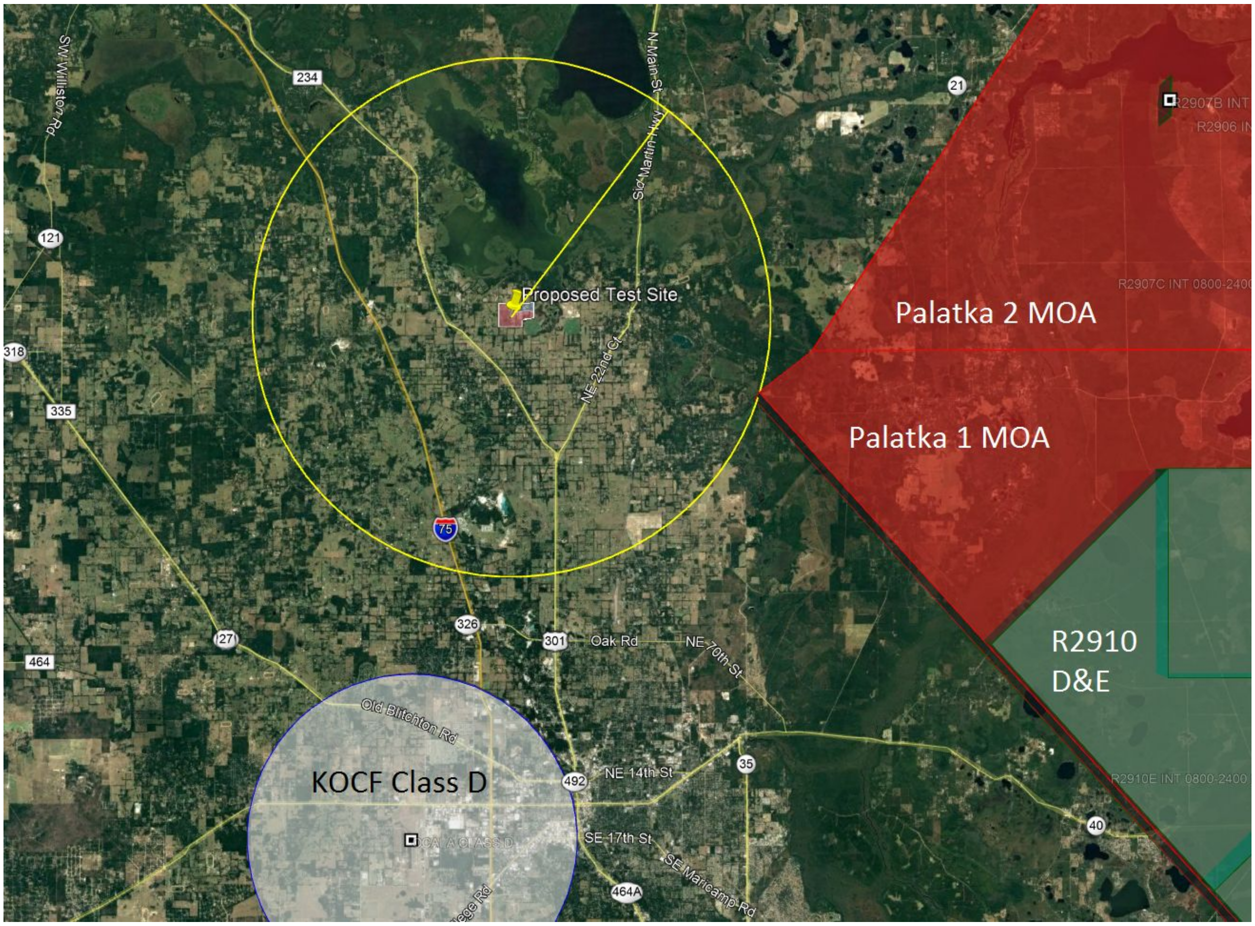
Appendix C - Flight Test Area



The above image is the proposed test site in Citra, FL (29°24'14.55"N, 82°10'30.70"W). It is the Plant Science Research Center, which is owned by the University of Florida.

The RED are areas where we would be conducting operations. The BLUE areas are buildings occupied by the University of Florida Plant Science Research Center. We would **not** be conducting operations in those areas.

This location is remote and there is not any restricted and/or Class B,C,D airspace within approximately 8 miles radius of the location:



In addition, all flights will be conducted below 400ft AGL, thus, all flights will occur in Class G airspace.

Appendix D - Proposed Flight Test Operations

The vehicle will be used to test new flight control schemes and vehicle performance. As such, flights will be closely planned before every flight. Example missions may include race track patterns, or straight line out-and-back flights around at test site described in Appendix C - Flight Test Area.

At no time will the vehicle be operated outside the test site. Furthermore, all missions will be planned away from test site boundaries.

The following is a list of general flight test operations and restrictions.

Max Operating Altitude

1. The altitude of the unmanned aircraft will not be higher than 400 feet above ground level

Max Operating Speed

1. The groundspeed of the unmanned aircraft will not exceed 50 knots

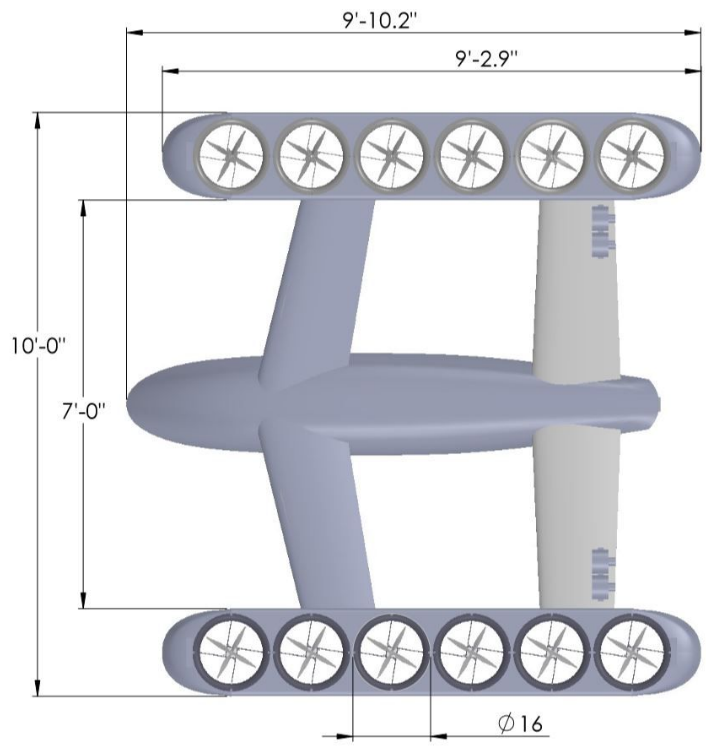
Flight Limitations

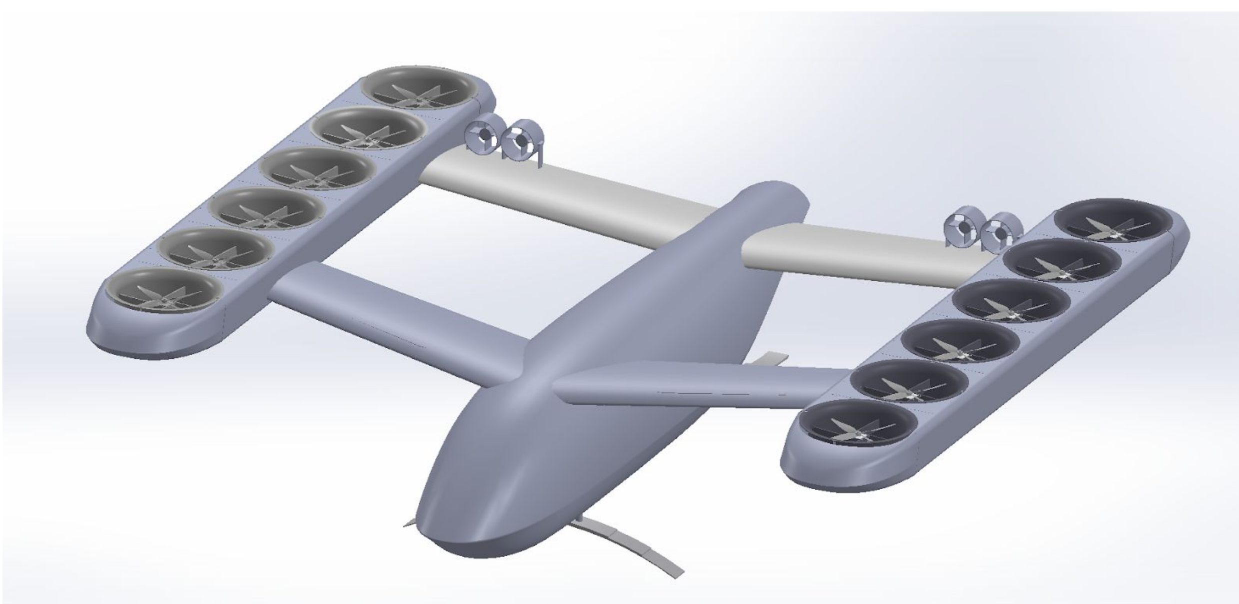
1. Day Visual Flight Rules (VFR) in visual meteorological conditions (VMC)
   a. The minimum flight visibility, as observed from the location of the control station must be no less than 3 statute miles. For purposes of this section, flight visibility means the average slant distance from the control station at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.
   b. The minimum distance of the unmanned aircraft from clouds must be no less than:
      i. 500 feet below the cloud; and
      ii. 2,000 feet horizontally from the cloud.
2. Icing Conditions: Flight operations in icing conditions will be prohibited
3. Ambient Outside Temperature (OAT)
   a. a. Maximum OAT: 120°F/49°C
   b. b. Minimum OAT at Altitude: -20°F/-29°C
4. Wind Limitation
   a. 25 knots
5. UAS shall be operated under 14 C.F.R. Part 91, operating requirements, as mitigated. Operations shall be conducted in accordance with a waiver of flight regulations applicable to the operation issued by the Administrator and specific to the intended operation, including geographical limitations.

6. For this operation only one aircraft is requested to be airborne any given time
7. Flight are not requested for over water operation
8. All operations in these areas are requested to be limited to line of sight only. (See Max. Operating Altitude Section above.)

<u>Appendix E - Aircraft Information</u>

The vehicle is registered as **N213A**, which is a **UNIV OF FLORIDA UASRP LAB UF16000.** An overview of the aircraft is contained in this section.





Aircraft Performance & Limitations

- Airspeeds
  - VNE (Never Exceed) - 50 knots
  - VNO (Maximum Cruising Structural Speed) - 50 knots
  - VA (Maneuvering Speed) - 25 knots
- Range @ Cruise Speed - 2.5 NM
- Endurance @ Cruise Speed - 5 minutes
- Rate of Climb, Sea Level - 1000 ft/min
- Take-Off Performance - Vertical Take-Off (No Ground Roll)
- Landing Performance - Vertical Landing (No Ground Roll)
- Stall Speed - 17 knots
- Wing Loading - 9.8 lb/sq.ft.
- Disk Loading - 15 lb/sq.ft
- Fuel Capacity
  - The **UNIV OF FLORIDA UASRP LAB UF16000** is powered by rechargeable Lithium-polymer batteries, see information listed under Battery section
- Battery
  - Lithium-polymer rechargeable batteries with onboard monitoring system
  - Hover Battery Sub-System
    - Manufacturer: MaxAmps, Inc
    - 4 x 22 Amp hour, 44.4V (nominal)
    - Note: These battery supplies power for the hover motors, flight controllers and other avionics
  - Cruise Battery Sub-System
    - Manufacturer: MaxAmps, Inc
    - 2 x 10.9 Amp hour, 44.4V (nominal)
    - Note: These battery supplies power for the hover motors, flight controllers and other avionics
- Oil Capacity
  - Not Applicable
- Engine
  - Electric Motors
    - Hover Sub-System
      - Manufacturer: Hacker Motors
      - Model: Q80-16.3-8
      - Peak Power: 6kW
      - Weight: 1.4 lbs
      - Number of Motors: 12
    - Cruise Sub-System

                - Manufacturer: Vasyfan
                - Model: VF-128-10
                - Peak Power: 10kW
                - Weight: 0.4lbs
                - Number Motors: 6
    - Motor Controller
        - Hover Sub-System
            - Manufacturer: Hacker Motor
            - Model: Master SPIN 220 Pro OPTO
            - Type: Electronic Speed Controller
            - Limits: 220Amps, Continuous
            - Weight: 361g
        - Cruise Sub-System
            - Manufacturer: Alien Power System
            - Model: ALIEN 400A 3-16S BOAT ESC HV
            - Type: Electronic Speed controller
            - Limits: 400A, Continuous; 16S Voltage
            - Weight: 450g
- Engine Limits
    - Hover Sub-System
        - Maximum Power Output: 6kW
        - Maximum RPM: 15,000RPM
        - Maximum Motor Temperature: 180°F
        - Maximum Motor, Controller Sub Assembly Temperature: 180°F
        - Minimum Voltage: 42.2V
    - Cruise Sub-System
        - Maximum Power Output: 11kW
        - Maximum RPM: 13,000RPM
        - Maximum Motor Temperature: 180°F
        - Maximum Motor, Controller Sub Assembly Temperature: 180°F
        - Minimum Voltage: 49.20V
- Propeller
    - Hover Propeller
        - Manufacturer: Master Air Screw
        - Model: 3X Power - 13x12 Propeller
        - Diameter: 13 inches
    - Cruise Propeller
        - Cruise propellers are in the ducted fan as a complete unit. See the Engine section.

Unmanned Aircraft Dimensions

- Length: 9’ 10.2”
- Wingspan: 10’
- Mean Aerodynamic Chord (MAC): 17.75”

Aircraft Loading Information

- Center of Gravity, Nominal
  - 62.75 inches
- Empty C.G. Range
  - Not applicable
- Datum
  - Tip of Nose
- Maximum Weight
  - Ramp: 195lb
  - Take-Off: 195lb
  - Landing: 195lb

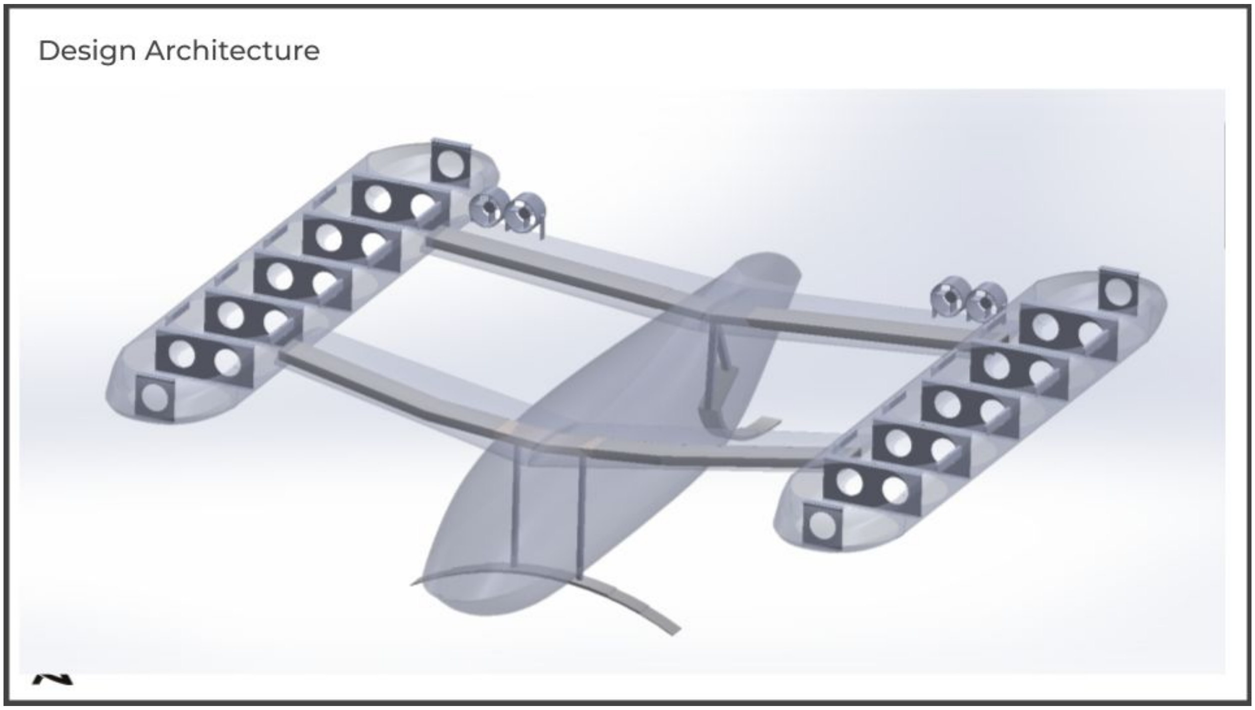
Communication Equipment

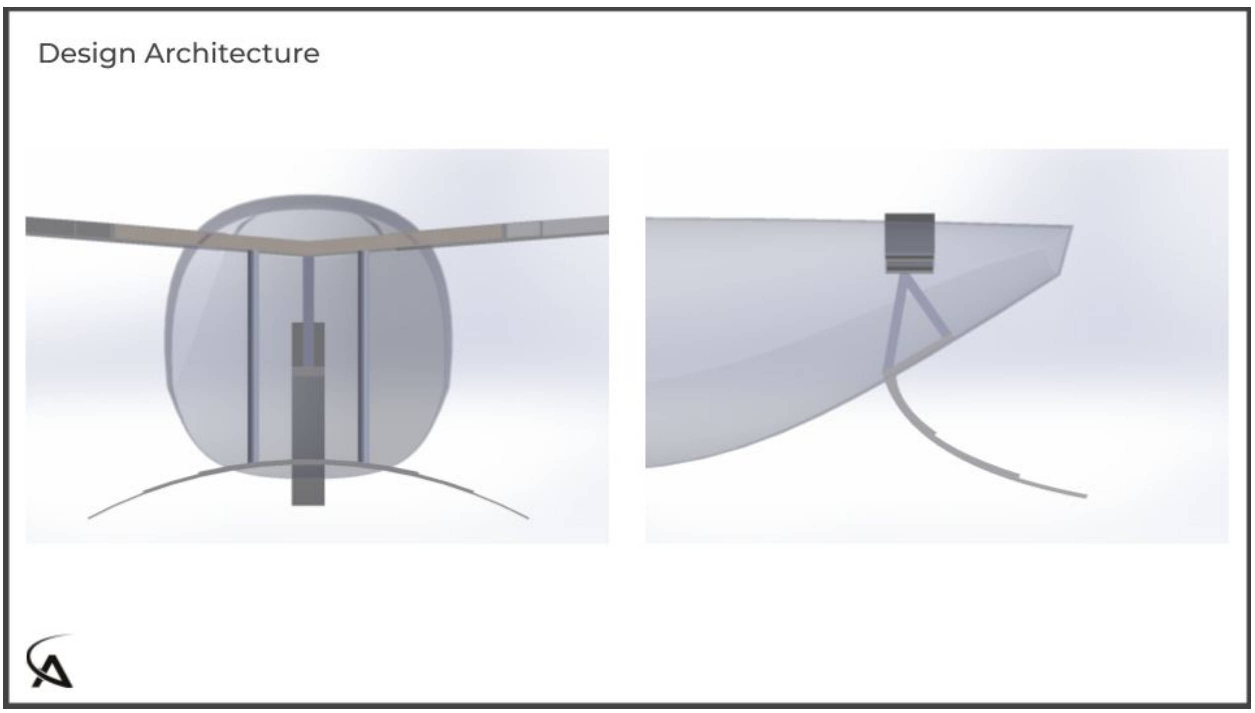
- TBS Crossfire TX and RX, DSSS, FHSS
  - Frequency: 915MHz
  - Communication protocol: DSSS, MAVLink
- Radio Altimeter, µLanding™ Lite Microwave Radar Altimeter
  - Frequency: 24GHz
  - Communication protocol: NA
- Transmitter, FRSKY
  - Frequency: 2.4GHz
  - Communication protocol: DSSS

Onboard Sensors

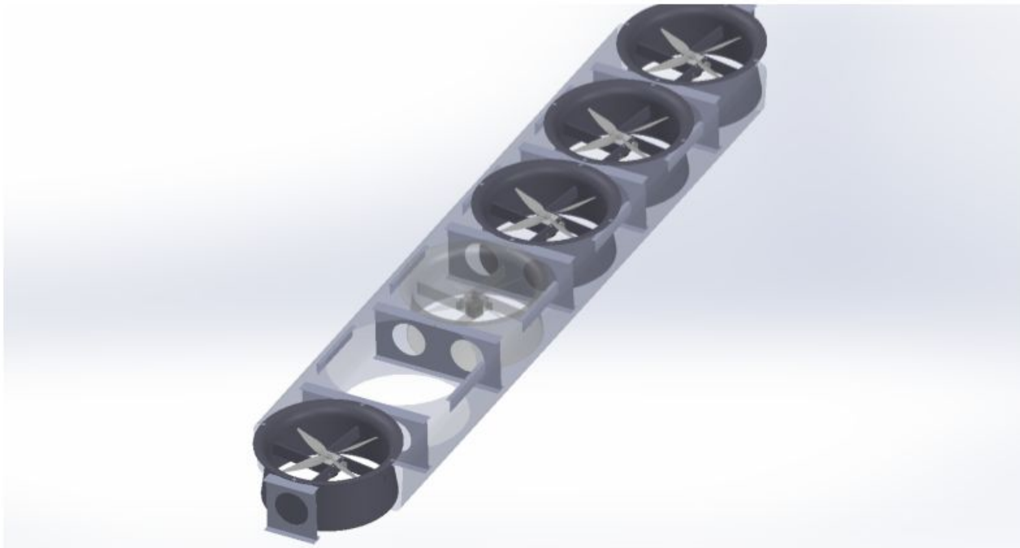
- 2x Inertial Measurement Units (IMU), each including, 3-axis accelerometer, 3-axis gyroscope and 3-axis magnetometer.
- GPS ZUbax GNSS2 with 3-axis magnetometer
- Radio Altimeter, µLanding™ Lite Microwave Radar Altimeter

<u>Structural Overview</u>



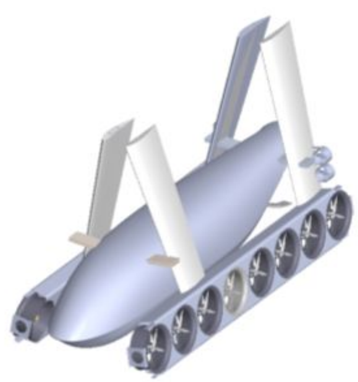


Design Architecture



Design Architecture

Similar folding as 8 Duct design. (shown here)



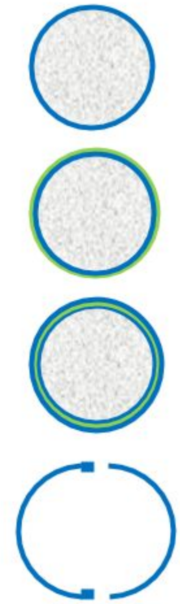
Manufacturing / Build Process

Build Sequence Overview

Fuselage, 1 required

Plug used as a positive of the fuselage shape

- Foam blanket sculpting, cutting and sanding EPS material using templates for accuracy
- Fiberglass over blank, three layers of 5 oz e-glass cloth and medium cure epoxy
- Sanding, filler and faring using high quality compound
- Paint using sandable gel coat applied with a spray gun
- Sand and polish to a high shine
- Tooling mold used to form the fuselage shell
- Parting agent, Part-all PVA mold release applied using a spray gun
- Thick gelcoat finish applied using a spray gun
- Fiberglass, multiple layers of fine to dense e-glass cloth and medium cure epoxy
- Strong-back material added to stiffen the mold
- Cure mold
- Cut in half along a vertical plane down the middle of the fuselage
- Joggle-gasket, applied to insure the two halves of the fuselage bond well



Build Sequence Overview

Fuselage continued

Fuselage shell two halves

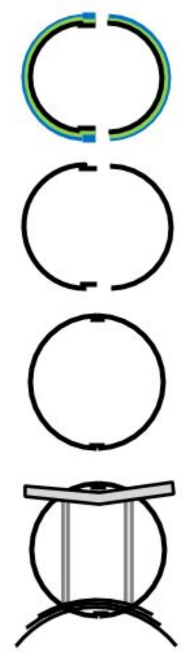
- Parting agent, Part-all applied with a spray gun
- Gelcoat, of the color chosen for the prototype applied with a spray gun
- Carbon fiber composite work
- Carbon fiber/epoxy, slow cure epoxy
- Foam strips for hat stiffeners applied in annular pattern in high load regions
- Carbon fiber over the hat stiffener foam
- Release film, breather material, vacuum bag, cure
- Remove joggle-gasket and remove fuselage halves from mold
- Join two halves of the fuselage with high strength thickened epoxy

Wing mounts

- Manufacture pass-through wing mount structure
- Layout locations for cutting openings for the pass-through wing mounts studs
- Glue in wing mount structure using high strength thickened epoxy

Landing gear hard-points

- Manufacture landing gear leaf springs
- Layout locations for landing gear pass-throughs
- Glue in landing gear structure using high strength thickened epoxy



Build Sequence Overview

Fuselage continued

Hatches
- Layout hatch locations
- Saw openings using Dremel cut-off wheel and retain dropping
- Reinforce around hatch openings with interior overhands
- Add flexible rubber trim on hatch edges
- Add hinges and flush mounted access latches

Mounts for batteries
- Manufacture battery trays
- Add battery straps on battery trays
- Fasten or glue battery trays inside the fuselage

Mounts for autopilot and other avionics
- Fabricate tray for autopilot
- Add mount hardware for autopilot
- Fasten or glue autopilot tray in the fuselage

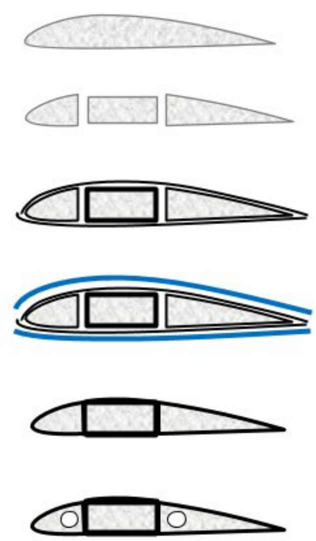
Send fuselage out for professional paint job

Build Sequence Overview

Wings, **4 required**

(1 right side front, 1 right side back, 1 left side front, 1 left side back)

Wing shell/structure for both front and back wings
- Cut/sand foam blank using hot wire and sand paper
- Cut wing-box spar portions using band saw
- Thin the foam box beam core to account for added layers
- Cut the two ends of the spar foam and replace with insert molds
- Carbon fiber composite work using carbon fiber/medium cure epoxy
- Wrap spar after mounting studs are inserted
- Wrap leading and trailing edges
- On rear wing add extra layers for pusher motor mounts
- Add extra layers on both ends of the wing
- Sandwich with mylars/plexiglass, vacuum bag and cure
- Cut to final shape to match the fuselage and the motor pods
- Hollow out foam in the spar for wire vias



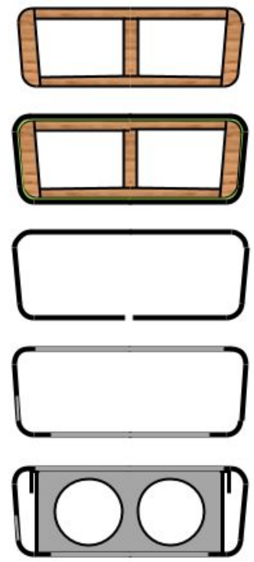
Build Sequence Overview

Motor Pods, **2 required**

Cowling fabrication
- Fabricate male tooling using plywood and lumber
- Plastic release film over the tooling, use polyethylene plastic
- Composite layup with carbon fiber/cork, multiple layer on inboard side
- Apply release plastic film, vacuum bag, and cure
- Cut lengthwise, down the middle and remove from mold
- Layout and cut openings for wing box pass-throughs
- and cut EDF holes on top side and bottom side of cowlings

Internal supports for EDFs
- Fabricate tooling for internal pod structures, I-beams, and angle brackets
- Composite layup of internal structures using carbon fiber prepreg

Pod assembly
- Glue in internal supports into the cowlings
- Mark locations for EDF inserts and glue in threaded inserts
- Glue in wire harness supports and ESC holders
- Glue in joggle gasket for nose cones

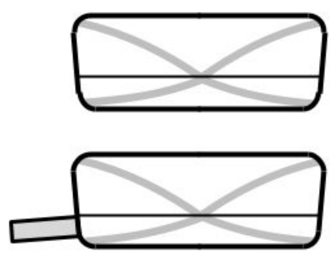


Build Sequence Overview

Motor Pods continued

Pod nose cones, 4 required
- Shape nose cone tooling using hard foam
- Composite layup using carbon fiber/epoxy, fast cure epoxy
- Faring compound and finishing
- Glue on nose cones to the rest of the pods
- Connect wings to motor pods
- Cut wing pass-throughs and glue wings to motor pods
- Add lightweight filler for creating wing/pod fillets
- Add carbon fiber/epoxy to fillets using fast cure epoxy

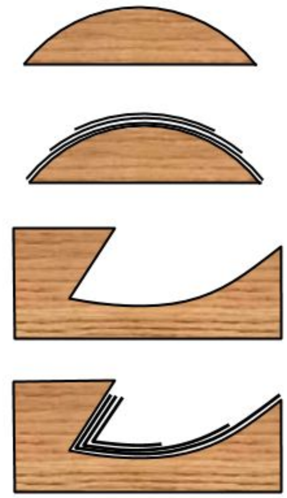
Send out for professional paint job



Build Sequence Overview

Landing Gear, front and back

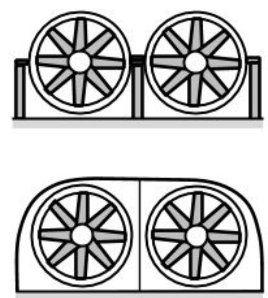
- Fabricate front landing gear leaf springs, three leaves
  - Fabricate tooling for landing gear using bent wood
  - Applied plastic release film
  - Composite layup with unidirectional carbon fiber epoxy prepreg
  - Peel-ply, breather, vacuum bag and cure
  - Sand, and finish using clear-coat
- Fabricate rear landing gear leaf springs, three leaves
  - Fabricate tooling for landing gear using bent wood
  - Applied plastic release film
  - Composite layup with unidirectional carbon fiber epoxy prepreg
  - Peel-ply, breather, vacuum bag and cure
  - Sand, and finish using clear-coat



Build Sequence Overview

Pusher Motors Supports

- Machine motor mounts using Delrin plastic
- Create tooling for pusher cowlings using 3D printing
- Mold release
- Composite carbon fiber/epoxy for cowlings
- Send out for professional paint job
- Mount on rear wings with pusher motors



Stress Analysis, Testing and Validation

- Use of mechanics of materials calculations to assess the three most critical locations of the vehicle (wing connections to the fuselage, front landing gear, back landing gear)
- Modeled worst case scenarios for loading, plus safety factor of 2.5 on strength of the materials used.
- Results were used to determine thickness and number of layers of composite material to be used
- Interior structure was simplified by making direct/axial loaded members to transmit loading from the wings directly to the landing gear.
- The fuselage was considered a floating shell, and only used to support batteries and avionics
- Testing of the load bearing capabilities will be conducted using sand bags placed on subcomponents (such as the wing, pods, landing gear) individually, then on the structure once it has been assembled. Sand bags are an accurate, safe and effective method to simulate both point loads as well as distributed loads.

Appendix F - Briefings

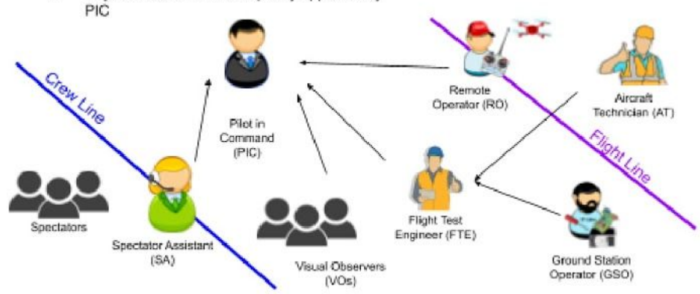
Unmanned Aircraft Systems Research Program

2005 SW 23rd Street
IFAS Field Labs; Bldg #:0343
Gainesville, FL 32608

Pilot-in-Command (PIC) Field Briefing Checklist

- **Flight Area**
    - Airspace & Flight Boundaries (Height & Footprint)
- **Hazards**
    - Area Restrictions (e.g. Powerlines, Greenhouses, Shands-Cair etc.)
- **Weather**
    - Wind (Point Aircraft Towards the Wind)
    - Inclement Weather
- **Emergency Procedures**
    - Alternate Landing Area
    - Lost Comms
    - Lost Link
    - Engine Out
    - Vehicle Kill Switch
    - Injury
- **Roles of Flight Crew**
    - Crew
        - Pilot-in-Command (PIC)
        - Remote Operator (RO)
        - Flight Test Engineer (FTE)
        - Aircraft Technician (AT)
        - Ground Station Operator (GSO)
        - Visual Observers (VO)
    - Spectators
    - Crew Line
    - Flight Line

Sterile Cockpit Rules:
- Refrain from non-essential communication
- VOs report only emergency info to RO
- All others comms directed to PIC/FTE
- Any deviations must be explicitly approved by PIC



Questions?

Unmanned Aircraft Systems Research Program

2005 SW 23rd Street
IFAS Field Labs; Bldg #:0343
Gainesville, FL 32608

Flight Test Engineer (FTE) Field Briefing Checklist

- **Purpose of Flight**
- **Flight Card (High Level Review)**
  - Flight Maneuvers
  - Flight Modes

Questions?

Appendix G - Sample Flight Card

University of Florida Flight Test Card	
Date:	Aircraft:
Pilot:	Autopilot Version:
Engineer(s):	Aircraft Configuration:
	Test Location:
Flight #:	Weather:

University of Florida Flight Test Card – Broken-Loop Frequency Sweeps

1. ❑ **Pre-Flight and Initialization**
   - 1.1. ❑ Conduct pre-flight checklist and verify aircraft structure, systems, wiring, motors, and battery are suitable for flight
   - 1.2. ❑ Power on aircraft and verify link
   - 1.3. ❑ Verify airspeed sensor responds to pressure on pitot tube (if applicable)
   - **1.4.** ❑ Arm aircraft to start logging
2. ❑ **Set Frequency Sweep Parameters**

Parameter	Value	Units
FTI_MODE	0	0 = Sweep, 1 = Doublet
FTI_FS_DURATION	20	Seconds
FTI_FS_FREQ_BEGIN	0.1	Hz
FTI_FS_FREQ_END	10	Hz
FTI_FS_AMP_BEGIN	0.2	Depends on Injection Point
FTI_FS_AMP_END	0.2	Depends on Injection Point
FTI_FS_FREQ_RAMP	3	Nonlinear Change of Frequency With Time

3. ❑ **Take-Off**
   - **3.1.** ❑ Set mode to ***ATTITUDE (STABILIZED)***
   - **3.2.** ❑ Arm throttle
   - **3.3.** ❑ Use small amount of throttle to verify all motors rotating
   - **3.4.** ❑ Check vehicle response to small roll, pitch, and yaw inputs
   - **3.5.** ❑ Verify airspeed reading on GCS is zero or measuring windspeed (if applicable)
   - **3.6.** ❑ Take off and climb to 50 ft AGL
4. ❑ **Initial Control Assessment**
   - **4.1.** ❑ Command small roll angle doublets and verify aircraft responds to inputs (t = ___________)
   - **4.2.** ❑ Command small pitch angle doublets and verify aircraft response (t = ___________)
   - **4.3.** ❑ Command small yaw rate doublets and verify aircraft response (t = ___________)
   - 4.4. ❑ Command small throttle variation and verify aircraft response (t = ___________)

5. ❑ **Roll Axis Broken-Loop Frequency Sweeps**

5.1. ❑ Verify mode is set to ***ALTITUDE***

5.2. ❑ Set ***FTI_INJXN_POINT = 1***

5.3. ❑ Maneuver aircraft away from obstacles or obstructions

5.4. ❑ Climb to 50 ft AGL or higher

5.5. ❑ Brief pilot on emergency procedure to terminate sweep (change mode / set ***FTI_ENABLE = 0***)

5.6. ❑ Roll Sweep #1

5.6.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #1 (t = __________)

5.6.2. ❑ Monitor aircraft attitude response. Terminate sweep if roll or pitch exceed +/- 30 degrees or if excessive altitude loss.

5.6.3. ❑ Set ***FTI_ENABLE = 0*** to end or reset sweep

NOTES: ____

5.7. ❑ Increase sweep amplitude if aircraft attitude response is less than 5 degrees

FTI_FS_AMP_BEGIN = ______________(0.3?)

FTI_FS_AMP_END = ______________(0.3?)

5.8. ❑ Roll Sweep #2

5.8.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #2 (t = __________)

5.8.2. ❑ Monitor aircraft attitude response during sweep

5.8.3. ❑ Set ***FTI_ENABLE = 0*** to end sweep

NOTES: ____

5.9. ❑ Increase sweep frequency if aircraft is able to maintain altitude during sweep

FTI_FS_FREQ_END = _____________ (15?)

5.10. ❑ Roll Sweep #3

5.10.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #3 (t = __________)

5.10.2. ❑ Monitor aircraft attitude response during sweep

5.10.3. ❑ Set ***FTI_ENABLE = 0*** to end sweep

NOTES: ____

6. ❑ Pitch Axis Broken-Loop Frequency Sweeps

6.1. ❑ Verify mode is set to ***ALTITUDE***

6.2. ❑ Set ***FTI_INJXN_POINT = 2***

6.3. ❑ Set ***FTI_FS_AMP_BEGIN = 0.2***

6.4. ❑ Set ***FTI_FS_AMP_END = 0.2***

6.5. ❑ Set ***FTI_FS_FREQ_END = 10***

6.6. ❑ Maneuver aircraft away from obstacles or obstructions

6.7. ❑ Climb to 50 ft AGL or higher

6.8. ❑ Brief pilot on emergency procedure to terminate sweep (change mode / set ***FTI_ENABLE = 0***)

6.9. ❑ Pitch Sweep #1

6.9.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #1 (t = __________)

6.9.2. ❑ Monitor aircraft attitude response. Terminate sweep if roll or pitch exceed +/- 30 degrees or if excessive altitude loss.

6.9.3. ❑ Set ***FTI_ENABLE = 0*** to end or reset sweep

NOTES: ____

6.10. ❑ Increase sweep amplitude if aircraft attitude response is less than 5 degrees

FTI_FS_AMP_BEGIN = ______________(0.3?)

FTI_FS_AMP_END = ______________(0.3?)

6.11. ❑ Pitch Sweep #2

6.11.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #2 (t = __________)

6.11.2. ❑ Monitor aircraft attitude response during sweep

6.11.3. ❑ Set ***FTI_ENABLE = 0*** to end sweep

NOTES: ____

6.12. ❑ Increase sweep frequency if aircraft is able to maintain altitude during sweep

FTI_FS_FREQ_END = _____________ (15?)

6.13. ❑ Pitch Sweep #3

6.13.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #3 (t = __________)

6.13.2. ❑ Monitor aircraft attitude response during sweep

6.13.3. ❑ Set ***FTI_ENABLE = 0*** to end sweep

NOTES: ____

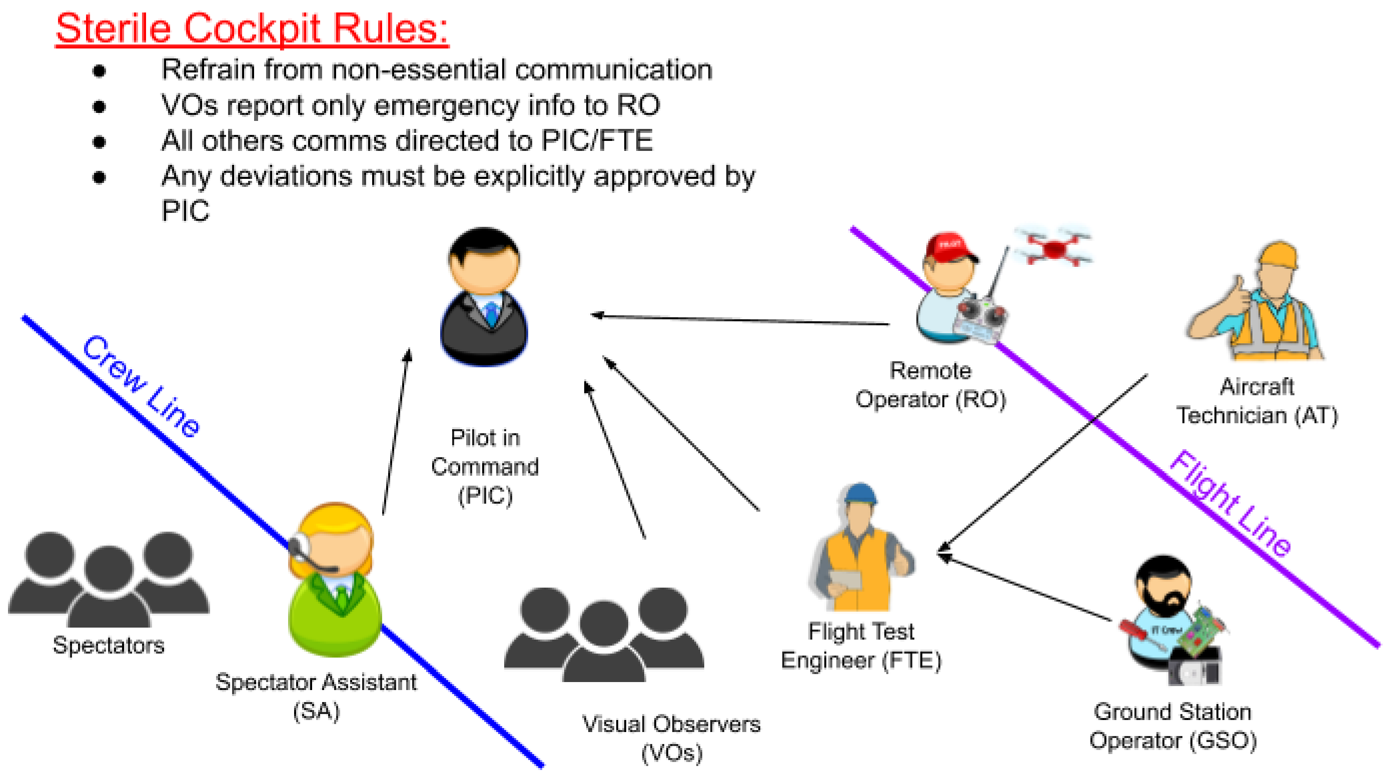
7. ❑ Pitch Axis Broken-Loop Frequency Sweeps

7.1. ❑ Verify mode is set to ***ALTITUDE***
7.2. ❑ Set ***FTI_INJXN_POINT = 3***
7.3. ❑ Set ***FTI_FS_AMP_BEGIN = 0.2***
7.4. ❑ Set ***FTI_FS_AMP_END = 0.2***
7.5. ❑ Set ***FTI_FS_FREQ_END = 10***
7.6. ❑ Maneuver aircraft away from obstacles or obstructions
7.7. ❑ Climb to 50 ft AGL or higher
7.8. ❑ Brief pilot on emergency procedure to terminate sweep (change mode / set ***FTI_ENABLE = 0***)
7.9. ❑ Yaw Sweep #1
 7.9.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #1 (t = __________)
 7.9.2. ❑ Monitor aircraft attitude response. Terminate sweep if roll or pitch exceed +/- 30 degrees or if excessive altitude loss.
 7.9.3. ❑ Set ***FTI_ENABLE = 0*** to end or reset sweep
 NOTES: ____
7.10. ❑ Increase sweep amplitude if aircraft attitude response is less than 5 degrees
 FTI_FS_AMP_BEGIN = _____________(0.3?)
 FTI_FS_AMP_END = _____________(0.3?)
7.11. ❑ Yaw Sweep #2
 7.11.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #2 (t = __________)
 7.11.2. ❑ Monitor aircraft attitude response during sweep
 7.11.3. ❑ Set ***FTI_ENABLE = 0*** to end sweep
NOTES: ____
7.12. ❑ Increase sweep frequency if aircraft is able to maintain altitude during sweep
 FTI_FS_FREQ_END = _____________ (15?)
7.13. ❑ Yaw Sweep #3
 7.13.1. ❑ Set ***FTI_ENABLE = 1*** to start sweep #3 (t = __________)
 7.13.2. ❑ Monitor aircraft attitude response during sweep
 7.13.3. ❑ Set ***FTI_ENABLE = 0*** to end sweep
 NOTES: ____

8. ❑ Landing and Recovery

8.1. ❑ Set aircraft to ***ATTITUDE (STABILIZE)***
8.2. ❑ Land aircraft
8.3. ❑ Disarm aircraft
8.4. ❑ Disconnect battery power
8.5. ❑ Recover flight data using USB cable or by removing SD cardg

Appendix H - Flight Test Personnel



a. PIC (Pilot in Command) is responsible for all operations and has the final authority in all matters. PIC is responsible for accurate Flight Logs. PIC is responsible for maintaining safe operation and enforcing Lines of Operation.
b. RO (Remote Operator) is a direct extension of the PIC. RO is solely responsible for the RC operation of the aircraft. RO must be able to take full control over the aircraft at any phase of flight. No member of the flight crew should communicate non-critical information to the RO unless explicitly approved by the PIC. The Flight Line is defined by the RO (no crew member--save the AT--should ever be between the RO and the aircraft) and enforced by the PIC..
c. VO (Visual Observed) are brought on only to help ensure line-of-sight with the aircraft. They report directly to the PIC and are not to relay any non-critical information to other members of the flight crew.
d. FTE (Flight Test Engineer) is responsible for understanding all technical aspects a flight and systems being evaluated. FTE is responsible for ensuring all technical personnel follow defined procedures and all technical equipment is accounted for preflight. FTE is responsible for Field Logs.

e. GSO (Ground Station Operator) will monitor remote sensors and relay any pertinent information to the FTE. Some operations may require control input from the GSO, it is important that all control requests are clearly defined and understood by the RO before a request is made.
f. AT (Aircraft Technician) reports directly to FTE and is responsible for all physical manipulation of the aircraft during normal procedures. AT is required to wear minimum safety equipment (closed toe shoes, long pants, long sleeve, safety glasses) during all operations and keep a pair of cut-proof gloves on their person to be worn when practical. AT will ALWAYS call "Battery Live" before plugging in aircraft power and "Battery Off" after unplugging power. AT is the only crew member permitted past the flight line during any battery live operations unless the aircraft is confirmed disabled by the PIC and FTE. AT may also be responsible for video logs when aircraft is operating if dedicated videographer is not defined.
g. SA (Spectator Assistant) communicates only with the PIC and is responsible for accommodating spectators questions, requests, etc. Crew Line is defined by the SA and SA will ensure no spectators interfere with crew during any operation.